US009187287B2

(12) **United States Patent**
Kikuchi et al.

(10) **Patent No.: US 9,187,287 B2**
(45) **Date of Patent: Nov. 17, 2015**

(54) **SHEET PROCESSING APPARATUS AND IMAGE PROCESSING SYSTEM**

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(73) Assignee: **Ricoh Company, Limited**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/140,706**

(22) Filed: **Dec. 26, 2013**

(65) **Prior Publication Data**

US 2014/0187407 A1 Jul. 3, 2014

(30) **Foreign Application Priority Data**

Dec. 28, 2012 (JP) 2012-288831

(51) **Int. Cl.**

B65H 45/18	(2006.01)
B31F 1/00	(2006.01)
B65H 45/12	(2006.01)
B65H 45/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B65H 45/18*** (2013.01); ***B31F 1/00*** (2013.01); ***B31F 1/0006*** (2013.01); ***B31F 1/0035*** (2013.01); ***B65H 45/04*** (2013.01); ***B65H 45/12*** (2013.01); *B65H 2301/51232* (2013.01); *B65H 2701/13212* (2013.01); *B65H 2801/27* (2013.01)

(58) **Field of Classification Search**

CPC B31F 1/00; B31F 1/0006; B31F 1/0035; B65H 45/12; B65H 45/04; B65H 2801/27

USPC 270/32, 45, 58.07

See application file for complete search history.

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Primary Examiner — Leslie A Nicholson, III

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(57) **ABSTRACT**

The present invention is concerning to a sheet processing apparatus comprising: a pressing member configured to press a folding line portion of a sheet bundle being folded; and a moving unit configured to move the pressing member to a folding line direction of the sheet bundle, wherein the pressing member pressurizes a part of the sheet bundle corresponding to a downstream side of a conveyance direction of the sheet bundle.

15 Claims, 14 Drawing Sheets

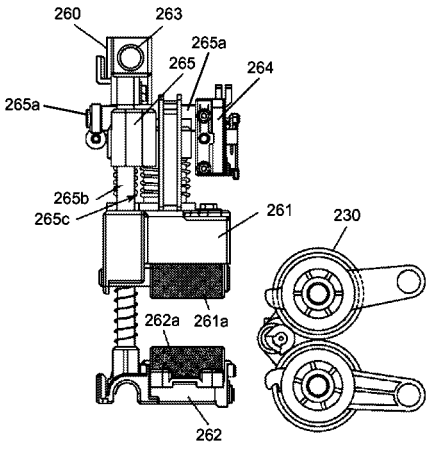

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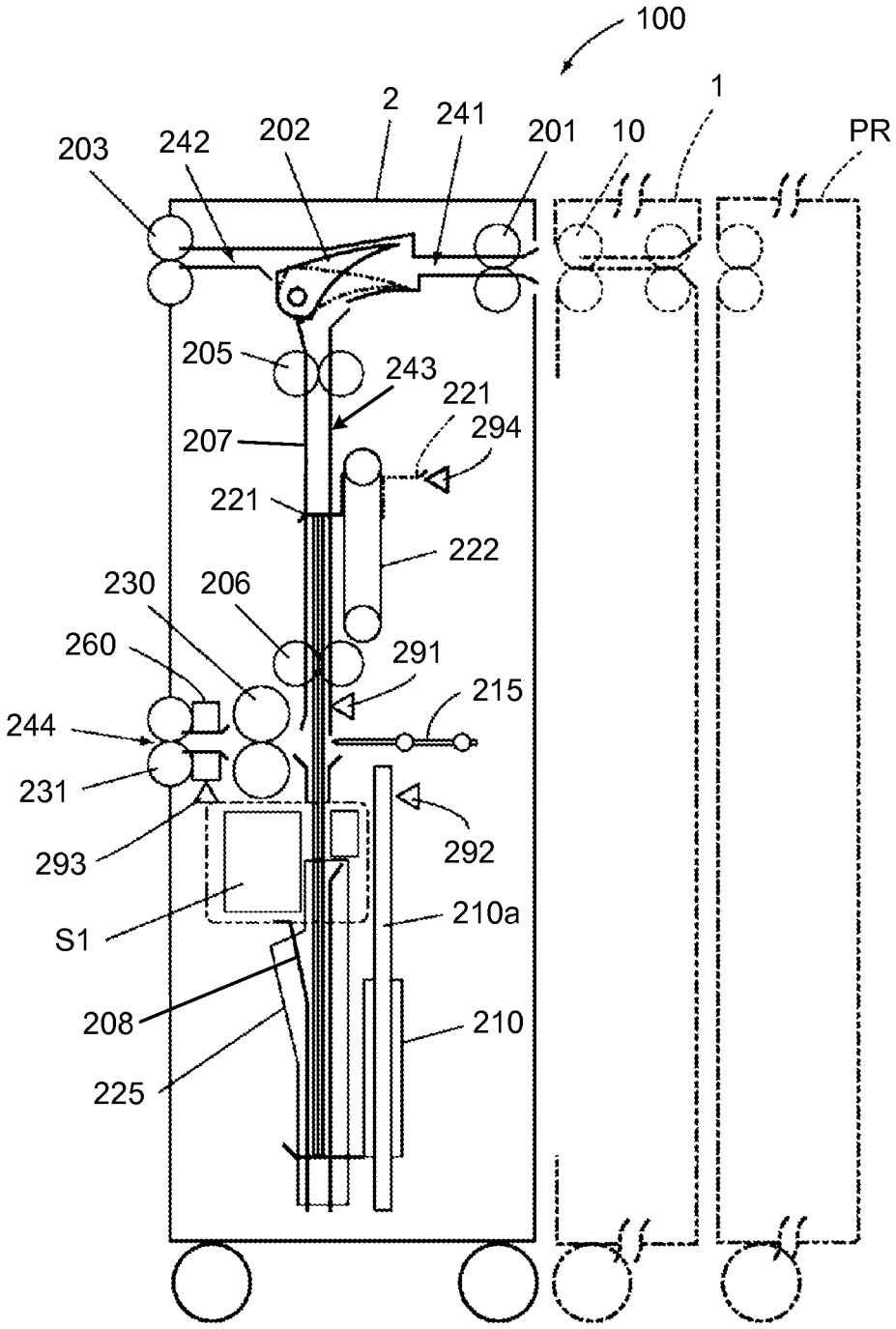
FIG.1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293
210a
S1
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FIG.2

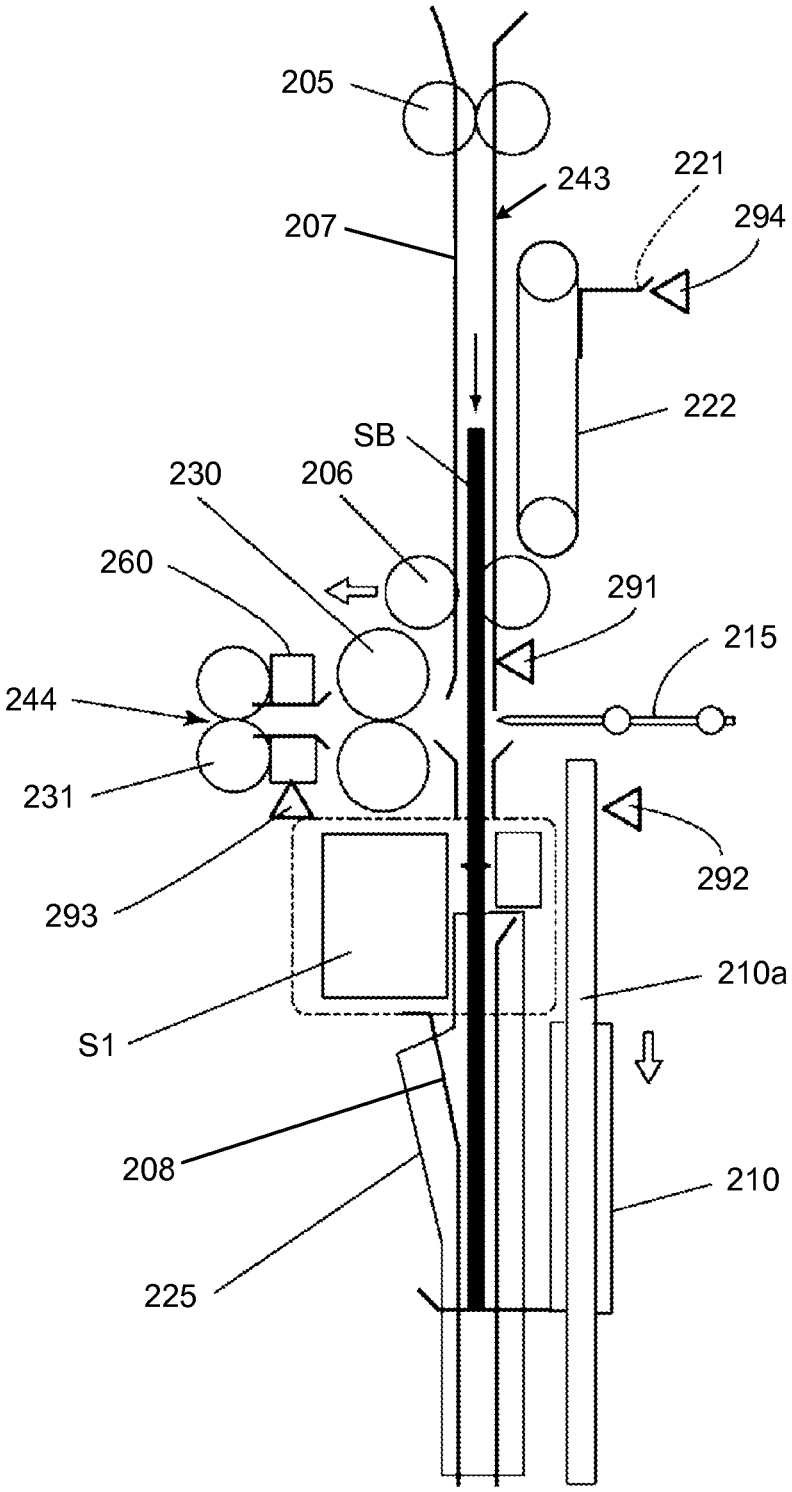
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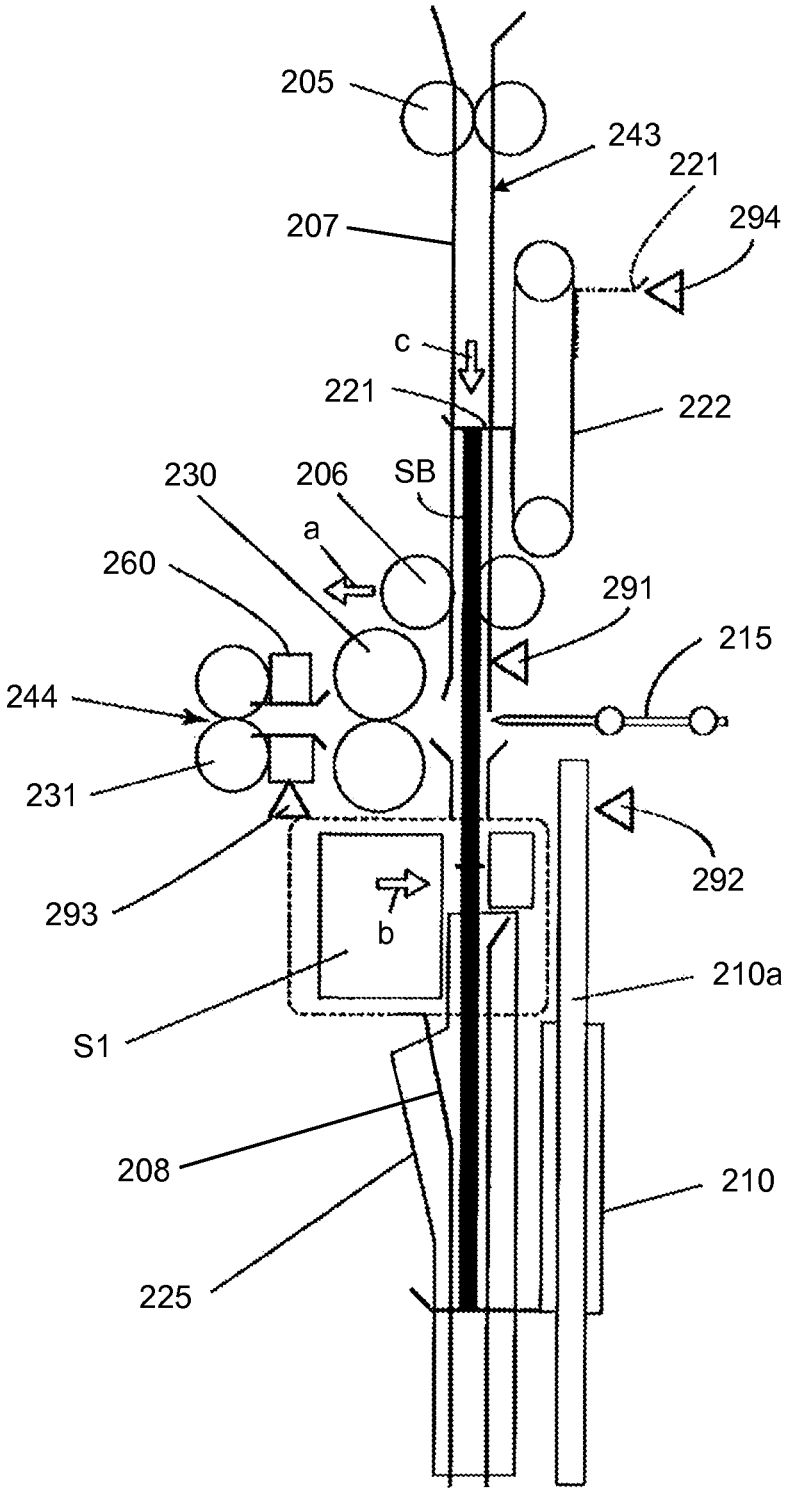
FIG.3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S1
208
210
225

FIG.4

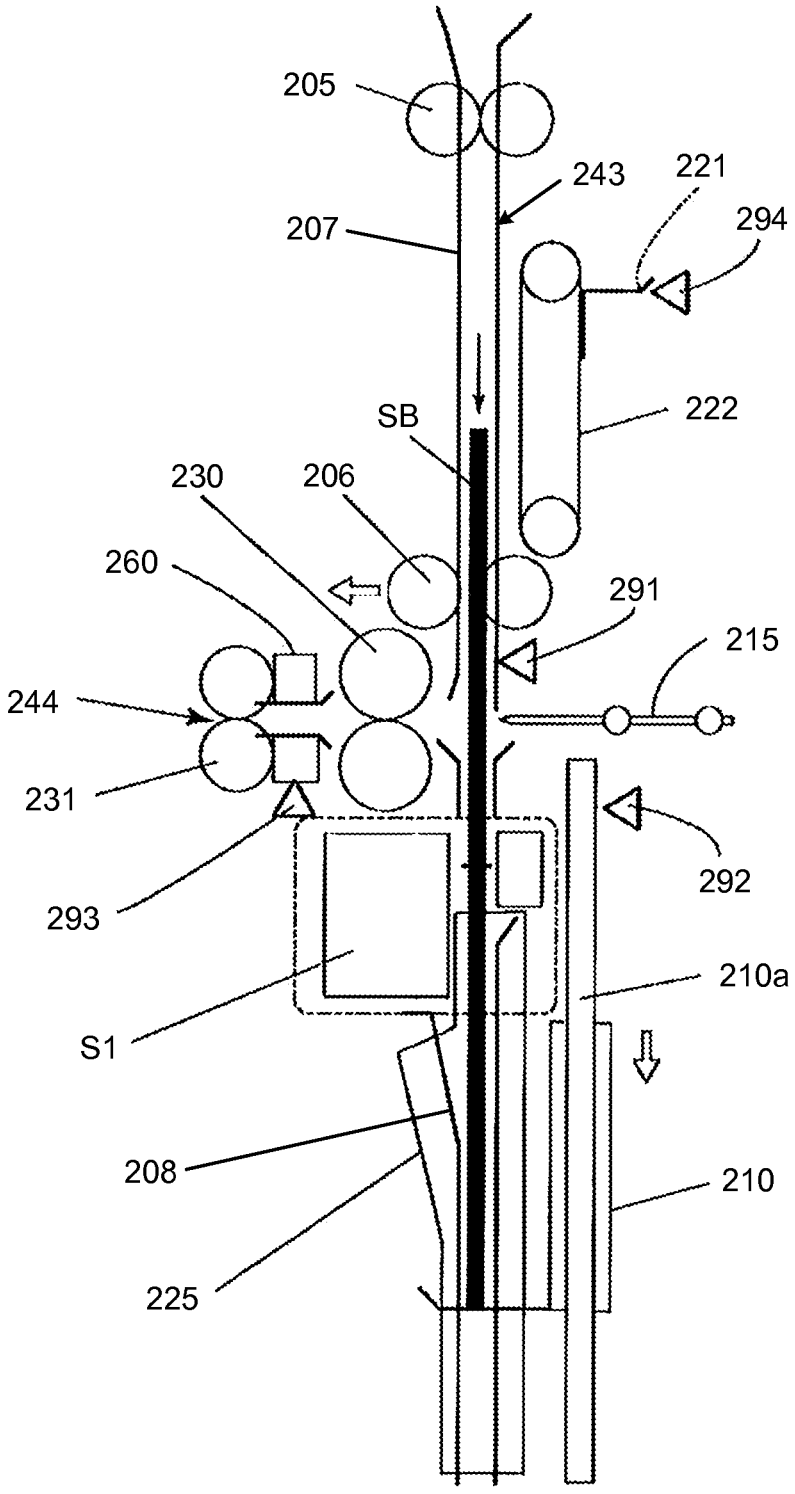
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FIG.5

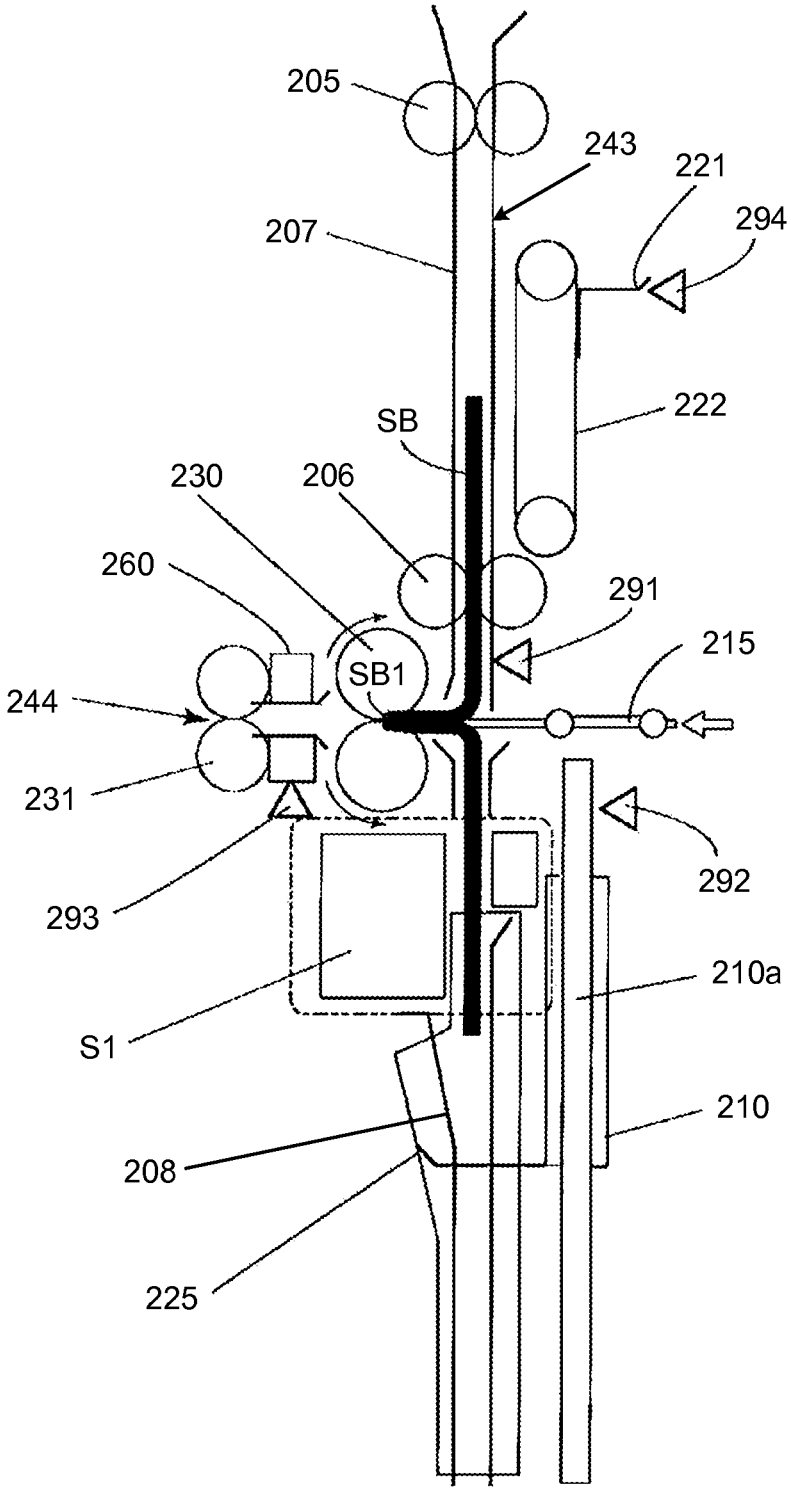
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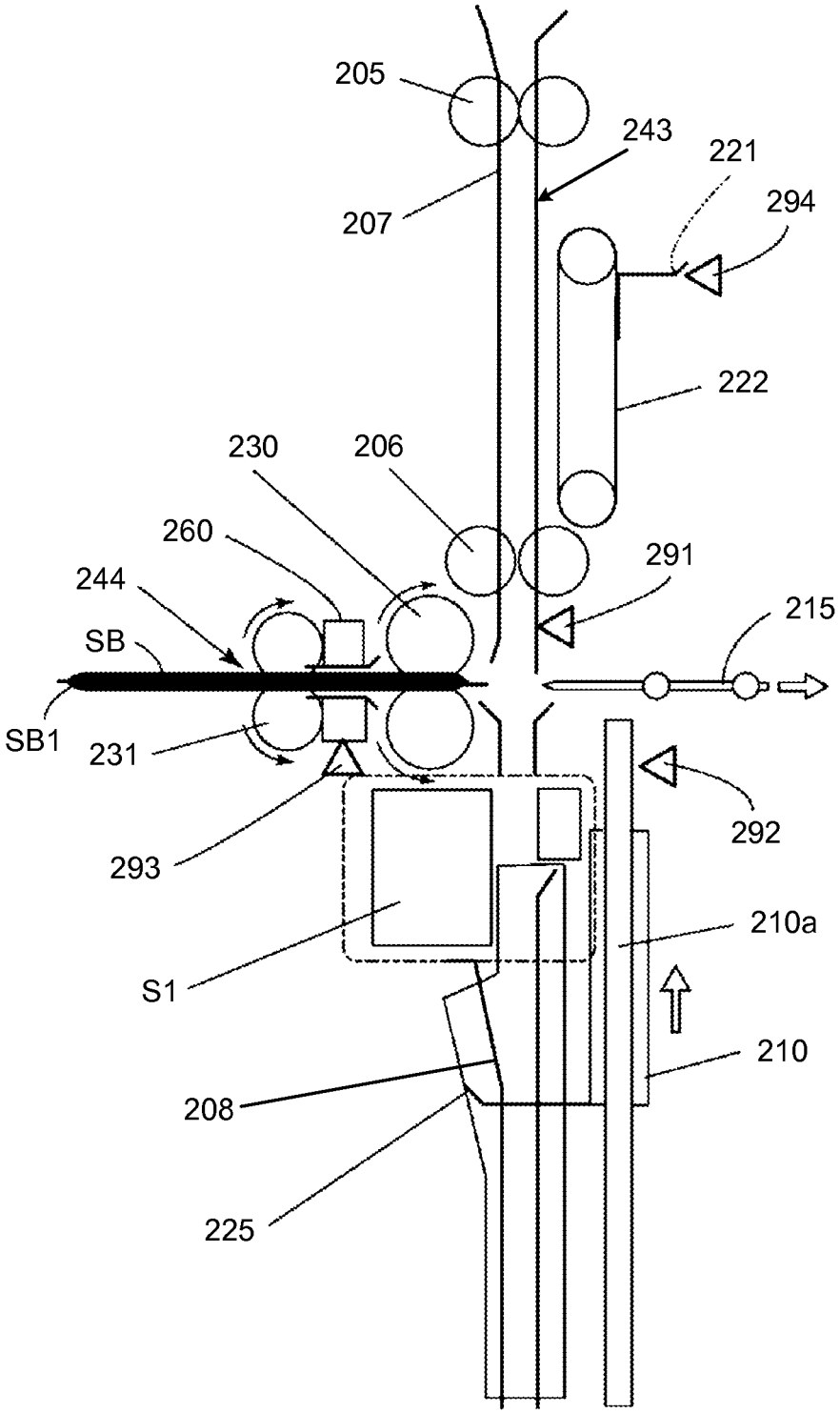
FIG.6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225

FIG.7

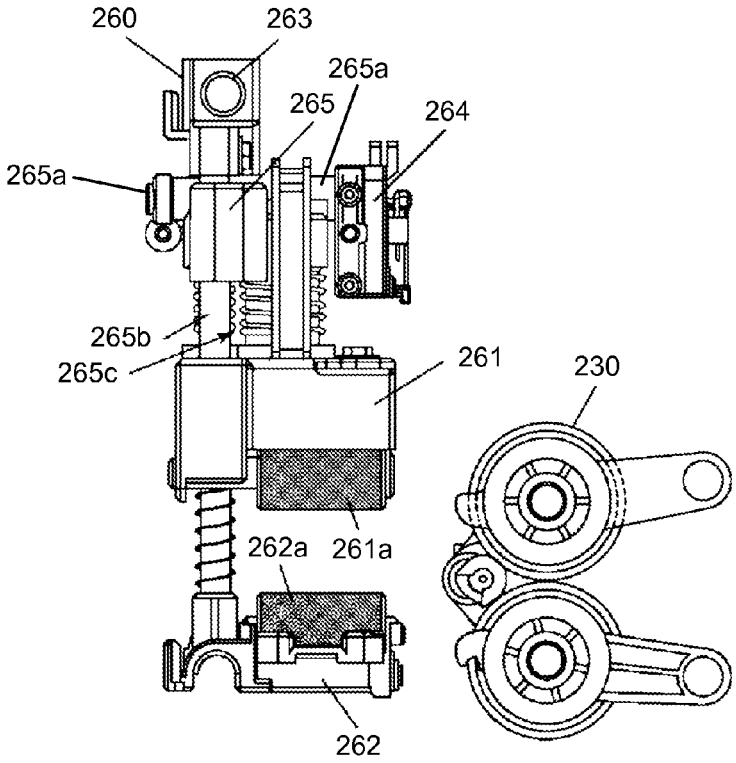
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FIG.8

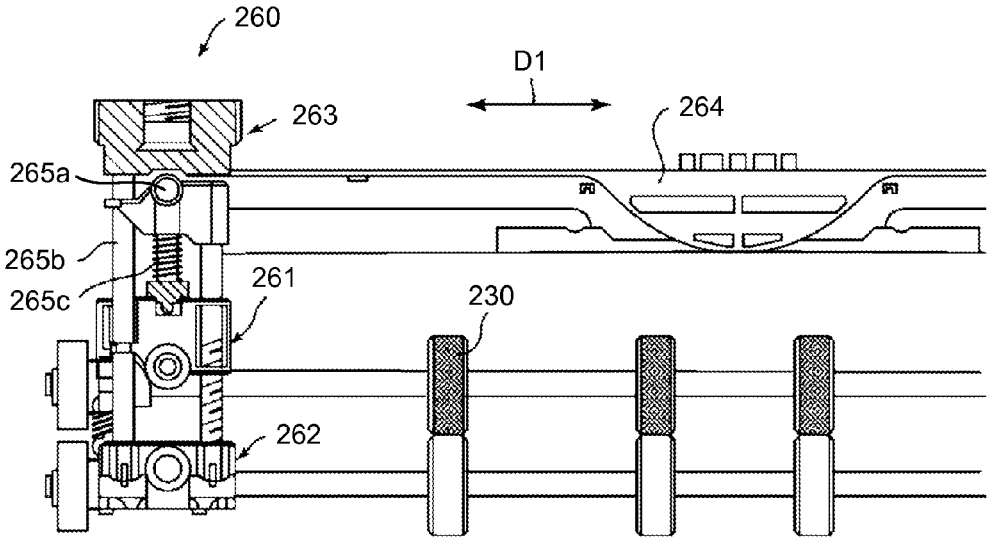
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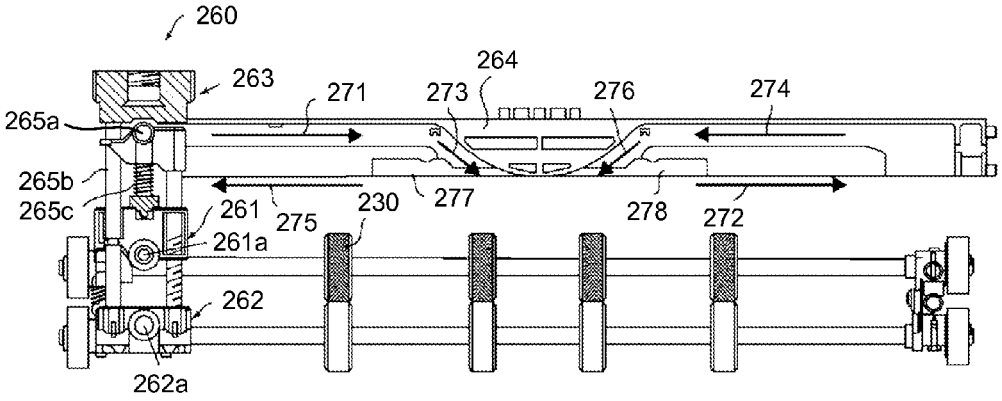
FIG.9



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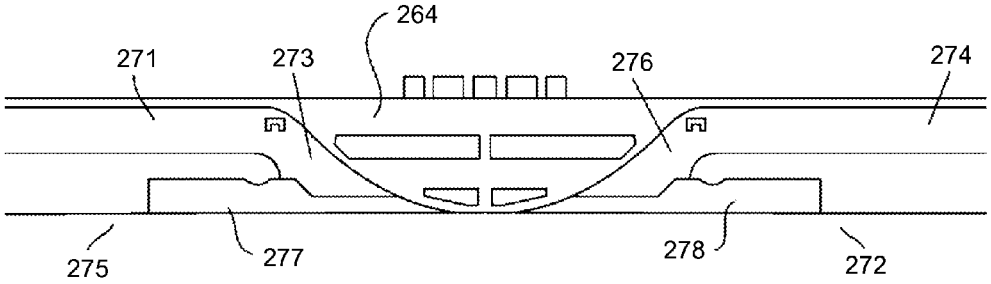

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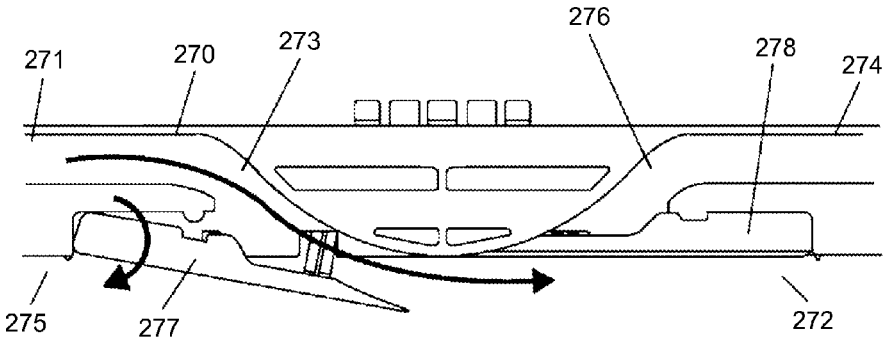


FIG.12

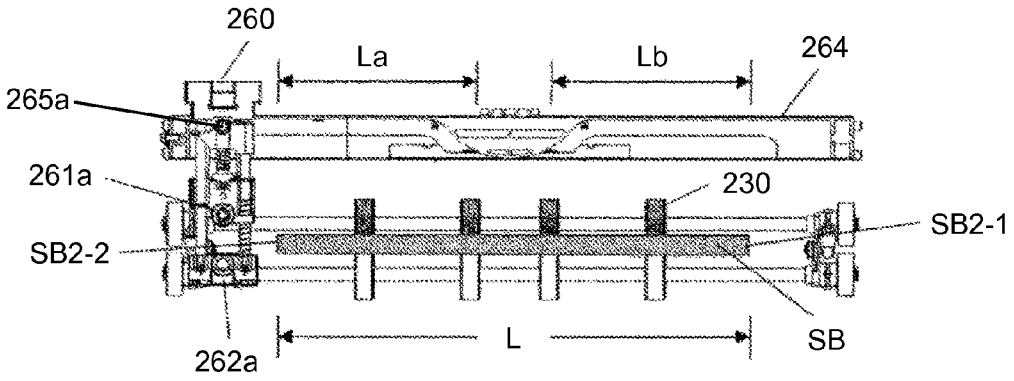


FIG.13

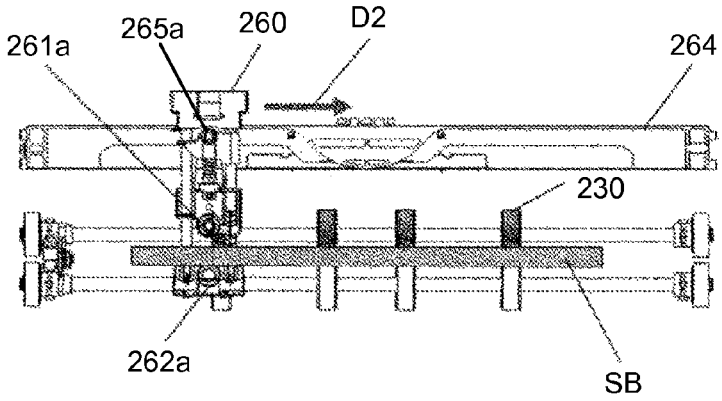


FIG.14

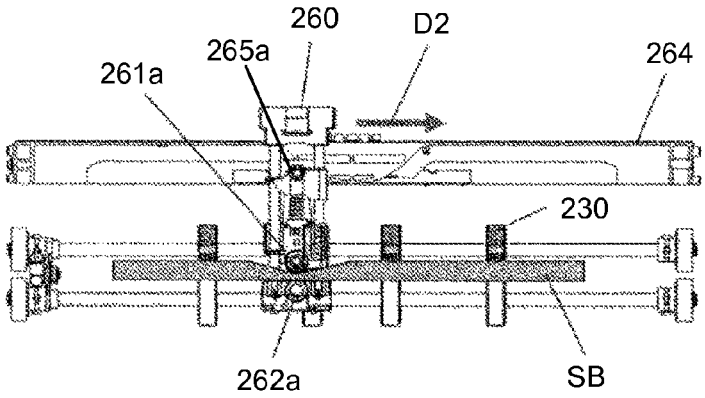


FIG.15

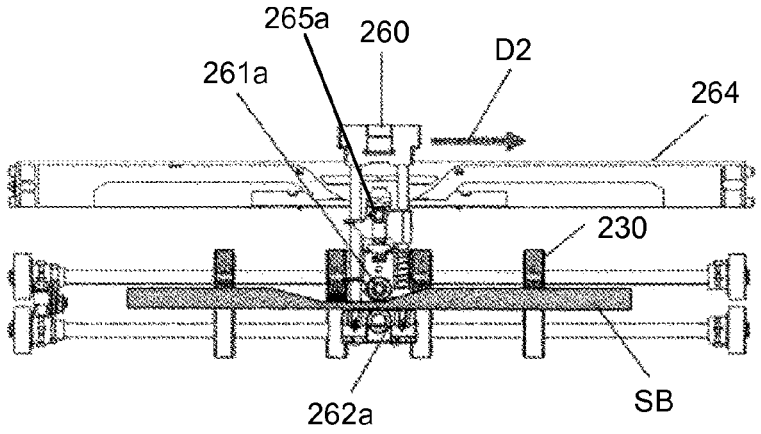


FIG.16

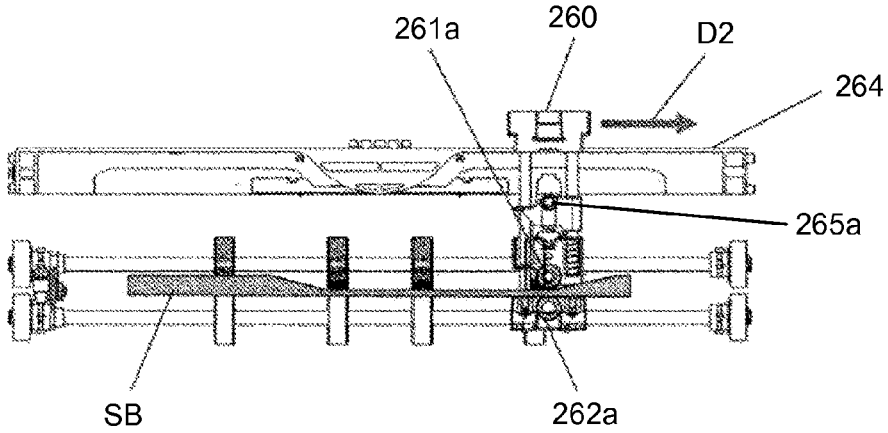


FIG.17

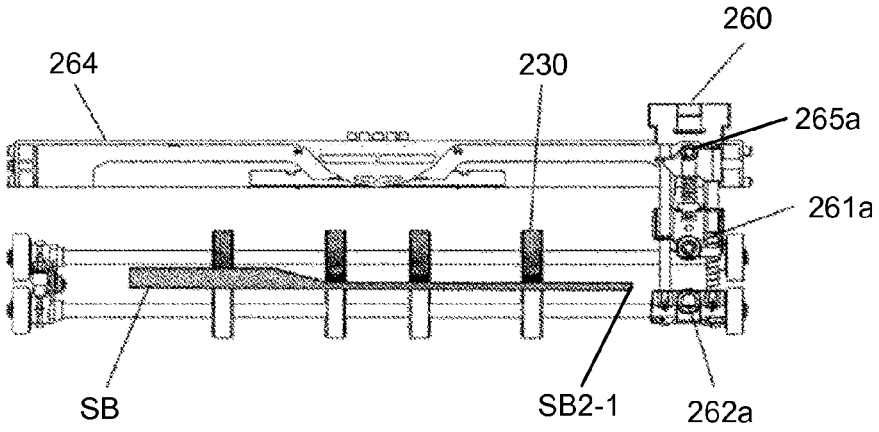


FIG.18

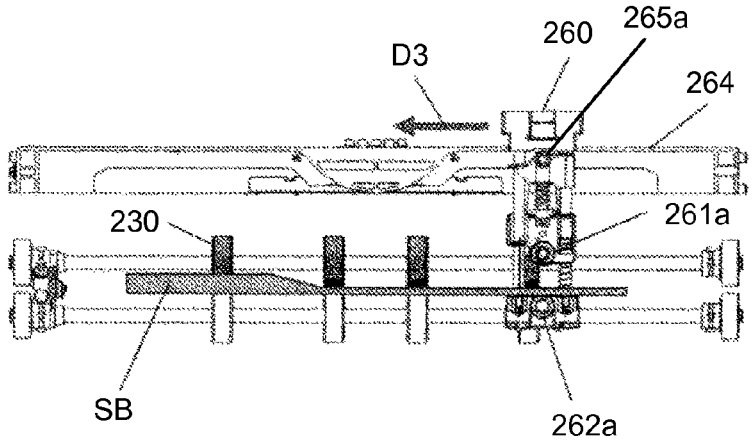


FIG.19

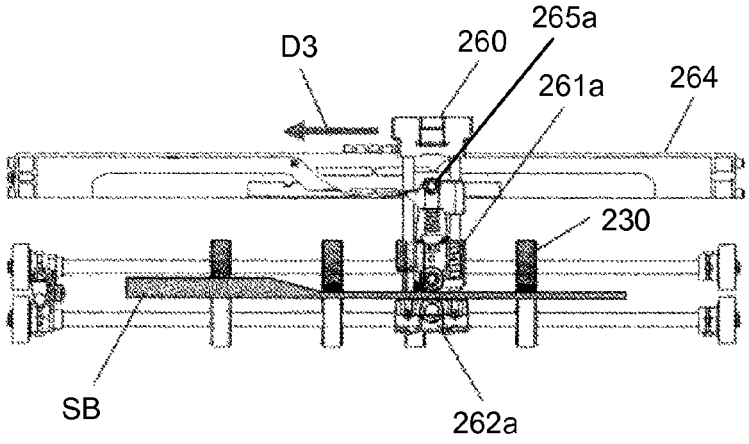


FIG.20

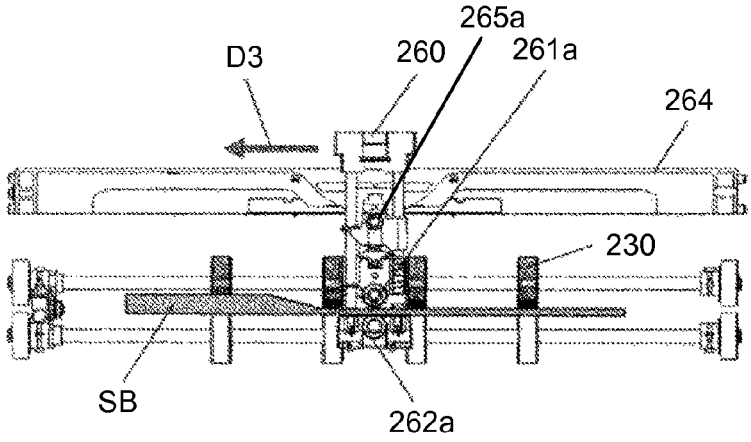
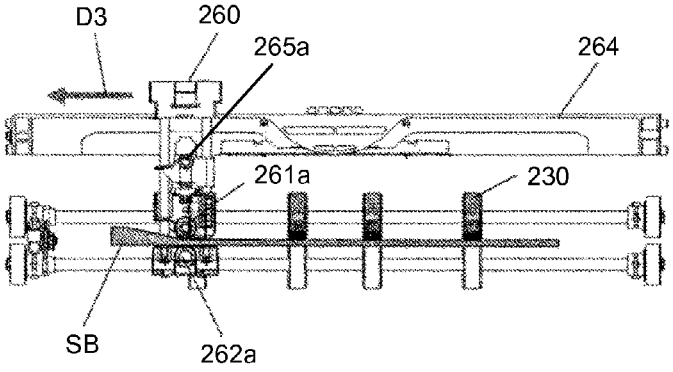


FIG.21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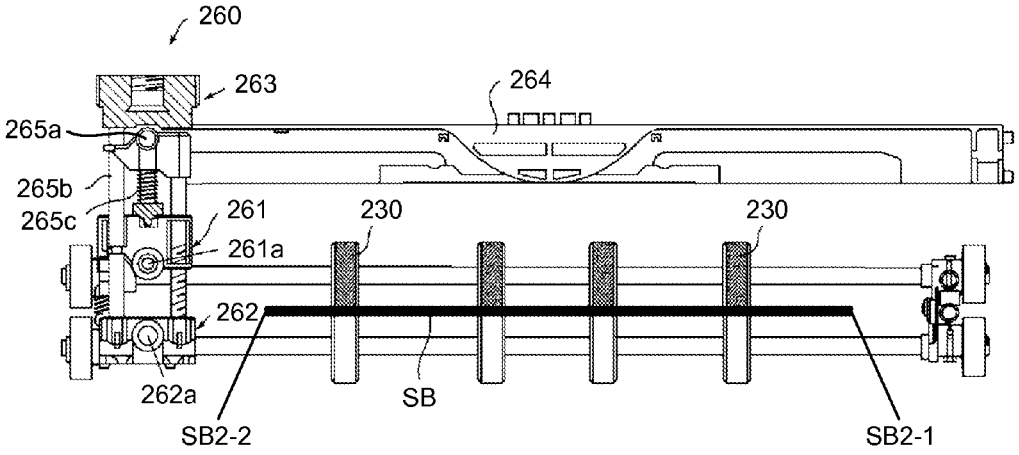
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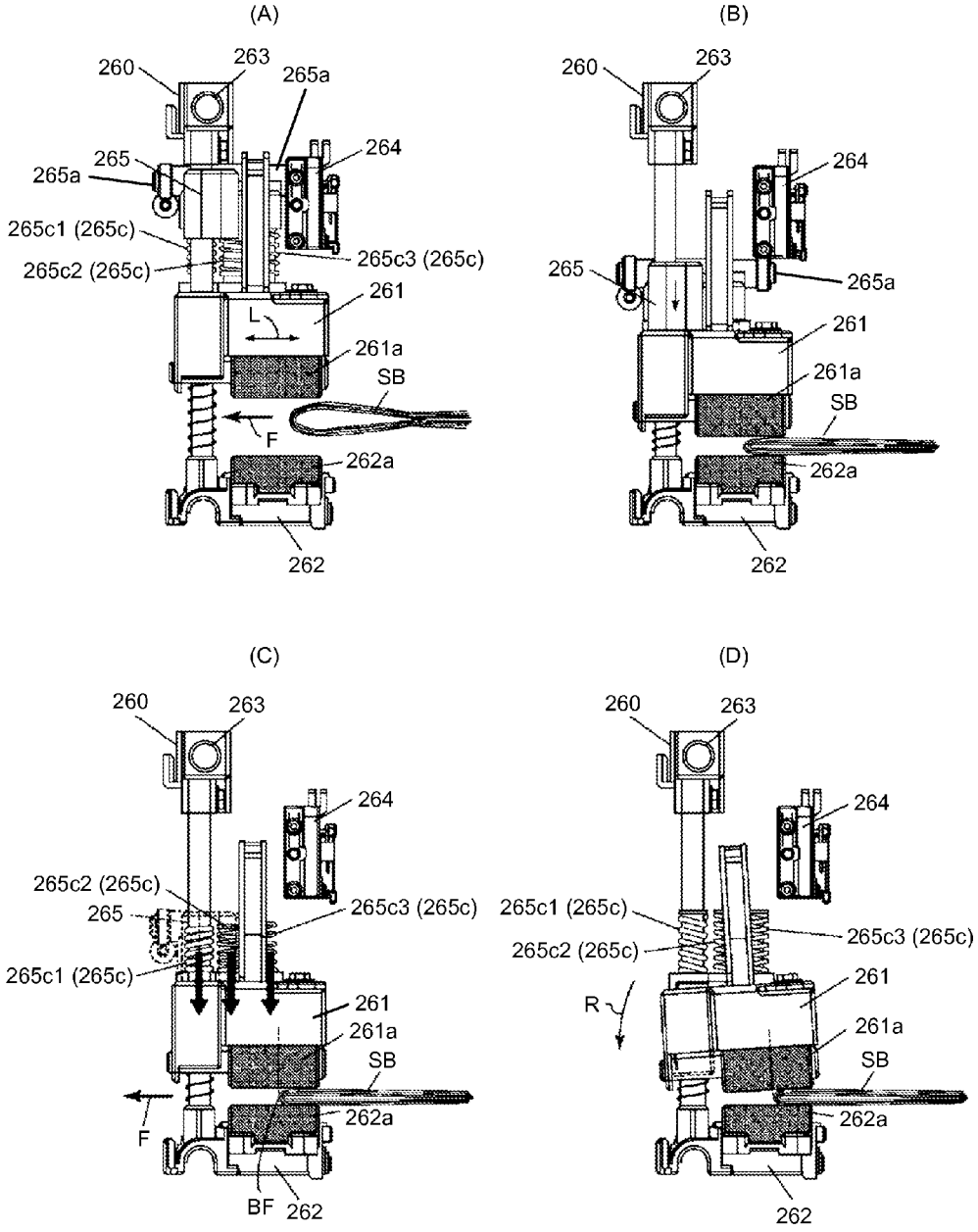
SB2-1

FIG.23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265c3 (265c)
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261a
SB
F
262a
262
(B)
260
263
264
265
265a
261
261a
SB
262a
262
(C)
260
263
264
265c2 (265c)
265
265c3 (265c)
265c1 (265c)
261
261a
SB
F
262a
BF
262
(D)
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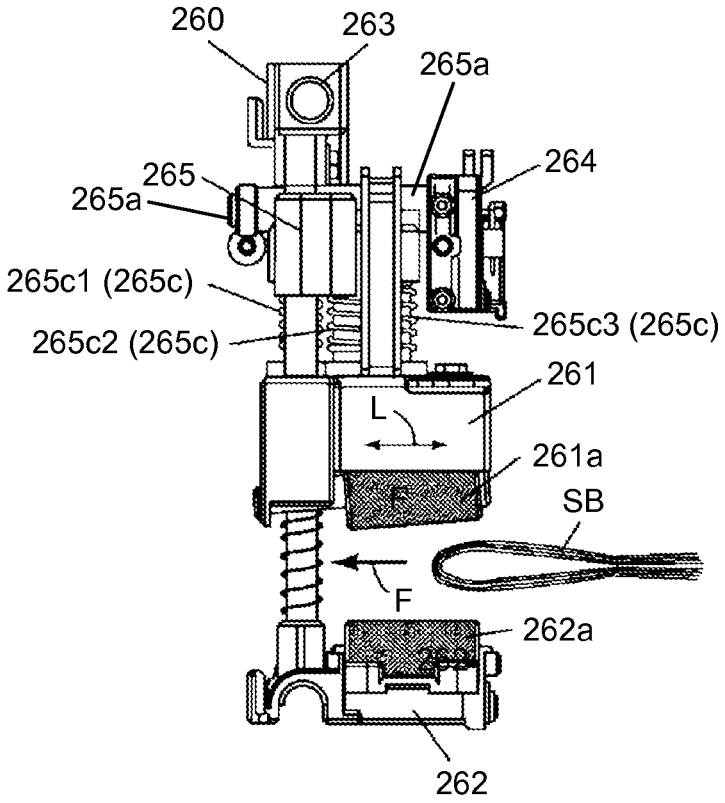
262

FIG.24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F
262a
262

SHEET PROCESSING APPARATUS AND IMAGE PROCESSING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2012-288831 filed in Japan on Dec. 28, 2012.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a sheet processing apparatus and an image processing system, more particularly to an additional folding process mechanism which reinforces a folding line of a center-folded sheet bundle formed of a sheet of paper or the like.

2. Description of the Related Art

A sheet such as a sheet of paper printed out by an image forming apparatus such as a copying machine, a printer, or a printing machine is discharged from the image forming apparatus in one case and, in another case, made into a booklet by a center folding process in which a center part of a predetermined number of sheets being put together is stitched and folded inside.

On the other hand, in order to reinforce the folding line at a center-folded part of the booklet formed of a saddle-stitched sheet bundle, there is known an additional folding work in which a roller moving along the back of the booklet is pressed against the folding line portion.

It is known that the additional folding work is configured to press the roller against the folding line portion while moving the roller parallel to a folding line direction, the roller having a shaft direction perpendicular to the folding line of the booklet.

Having been folded in, however, the folding line portion of the booklet is bulged out by a shape restoration force generated at the time the booklet is pressurized and folded up by the roller. The bulged-out portion is thus pressurized by an edge of the roller that is in contact with a sheet end side from a stitch position, namely, the folded booklet corresponding to an upstream side of a conveyance direction, in a direction perpendicular to the folding line direction. This kind of work sometimes causes damage such as a pressurized mark left in a pressurized part.

There has been proposed a configuration, as a configuration that reduces such damage, in which the direction of the roller pressurizing the folding line portion is tilted with respect to the folding line direction (refer to Japanese Laid-Open Patent Application Publication No. 2003-341930, for example).

This configuration gets rid of the bulged-out portion and avoids leaving the pressurized mark by stretching the bulged-out portion while using a component of force that is obtained from a tilt angle and works in a direction to generate tension on the sheet of paper at the time the roller adds pressure while moving along the folding line or what is called a back of the booklet.

The configuration disclosed in Japanese Laid-Open Patent Application Publication No. 2003-341930 can get rid of the bulge at the stitch position of the sheet of paper, but a shaft line of the roller is sometimes tilted due to processing accuracy or assembling accuracy of a mechanism used to add the pressurizing force.

In this case, the shaft line is tilted not in the aforementioned folding line direction but tilted relative to the surface of the booklet, specifically in a vertical direction relative to the surface.

This kind of tilt causes an edge of the roller in a width direction to be strongly pressed against a part of the sheet, thereby sometimes leaving the pressurized mark in the pressed part. Therefore, as it stands, the damage such as the pressurized mark done to the sheet cannot be completely eliminated even when the roller is tilted with respect to the folding line direction.

Considering the problem in the aforementioned sheet processing apparatus in the related art, there is need to provide a sheet processing apparatus and an image forming system including a configuration that can completely eliminate the damage such as the pressurized mark in pressurizing the center-folded part of the sheet.

SUMMARY OF THE INVENTION

It is an object of the present invention to at least partially solve the problems in the conventional technology.

According to the present invention, there is provided: a sheet processing apparatus comprising: a pressing member configured to press a folding line portion of a sheet bundle being folded; and a moving unit configured to move the pressing member to a folding line direction of the sheet bundle, wherein the pressing member pressurizes a part of the sheet bundle corresponding to a downstream side of a conveyance direction of the sheet bundle.

The present invention also provides an image processing system comprising an image forming apparatus and a sheet processing apparatus that saddle-stitches a sheet bundle and center-folds the sheet bundle, wherein the image forming apparatus is used as a preceding apparatus and the sheet processing apparatus is used as a following apparatus, and the image forming apparatus is connected to the sheet processing apparatus at a boundary corresponding to a position at which the sheet bundle is subjected to saddle stitching and center folding.

In the above-defined image processing system, the sheet processing apparatus comprises; a pressing member configured to press a folding line portion of the sheet bundle, and a moving unit configured to move the pressing member to a folding line direction of the sheet bundle, wherein the pressing member pressurizes a part of the sheet bundle corresponding to a downstream side of a conveyance direction of the sheet bundle.

The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating a system configuration of an image processing system including an image forming apparatus and a plurality of sheet processing apparatuses according to an embodiment of the present invention;

FIG. **2** is a diagram illustrating an operation of a saddle stitch book binding device where a sheet bundle is brought into a center folding conveyance path;

FIG. **3** is a diagram illustrating a state where the sheet bundle is saddle stitched by the saddle stitch book binding device;

FIG. **4** is a diagram illustrating a state where transferring of the sheet bundle to a center fold position is completed by the saddle stitch book binding device;

FIG. **5** is a diagram illustrating a state where a center folding process is performed on the sheet bundle by the saddle stitch book binding device;

FIG. **6** is a diagram illustrating a state where the center-folded sheet bundle is discharged by the saddle stitch book binding device;

FIG. **7** is a set of front views illustrating a principal part of an additional folding roller unit and a folding roller pair;

FIG. **8** is a side view illustrating a principal part of FIG. **7** seen from a left side;

FIG. **9** is a diagram illustrating a guiding member in detail;

FIG. **10** is an enlarged view illustrating a principal part of FIG. **9** where a path switching claw is not switched;

FIG. **11** is an enlarged view illustrating the principal part of FIG. **9** where a first path switching claw is switched;

FIG. **12** is a diagram illustrating an initial state of an additional folding operation;

FIG. **13** is a diagram illustrating a state where an additional folding roller unit starts a forward movement;

FIG. **14** is a diagram illustrating a state where the additional folding roller unit comes to a third guide path in the vicinity of a center of the sheet bundle;

FIG. **15** is a diagram illustrating a state where the additional folding roller unit pushes aside the first path switching claw and enters a second guide path;

FIG. **16** is a diagram illustrating a state where the additional folding roller unit moves into an edge direction while pressing the sheet bundle;

FIG. **17** is a diagram illustrating a state where the additional folding roller unit has moved to a final position of the forward movement along the second guide path;

FIG. **18** is a diagram illustrating a state where the additional folding roller unit starts a backward movement from the final position of the forward movement;

FIG. **19** is a diagram illustrating a state where the additional folding roller unit comes to a sixth guide path after starting the backward movement;

FIG. **20** is a diagram illustrating a state where the additional folding roller unit having come to the sixth guide path shifts from a non-pressed state to a pressed state;

FIG. **21** is a diagram illustrating a state where the additional folding roller unit is completely in the pressed state when having entered a fifth guide path;

FIG. **22** is a diagram illustrating a state where the additional folding roller unit returns to an initial position after moving through the fifth guide path;

FIGS. **23**(A) to **23**(D) are diagrams each illustrating a characteristic of the sheet processing apparatus according to an embodiment of the present invention to be applied to the configuration illustrated in FIG. **1** to FIG. **22**; and

FIG. **24** is a diagram illustrating a variation of the configuration illustrated in FIGS. **23**(A) to **23**(D).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Modes of carrying out the present invention will now be described on the basis of embodiments illustrated in the drawings.

A configuration and an operation of a sheet processing apparatus according to the present invention will be described first before describing a characteristic of an embodiment of the present invention.

FIG. **1** is a diagram illustrating a system configuration of an image processing system **100** including an image forming apparatus and a plurality of sheet processing apparatuses according to the present embodiment. In the present embodiment, an image forming apparatus PR is installed as an apparatus preceding first and second sheet processing apparatuses **1** and **2**, and the first and second sheet processing apparatuses **1** and **2** are connected in this order as apparatuses in the following stage.

The first sheet processing apparatus **1** is a sheet post-processing apparatus having a sheet bundle generating function which receives one sheet at a time from the image forming apparatus PR, stacks and aligns the sheet in succession, and generates a sheet bundle by a stack unit. The sheet bundle is discharged from a sheet bundle discharge roller **10** of the first sheet processing apparatus **1** to the second sheet processing apparatus **2** in the following stage.

The second sheet processing apparatus **2** is a saddle stitch book binding device which receives the sheet bundle being conveyed to perform saddle stitching/center folding (the second sheet processing apparatus described herein is also referred to as the saddle stitch book binding device).

The saddle stitch book binding device **2** discharges a bound booklet (sheet bundle) as is or to a sheet processing apparatus in the following stage. The image forming apparatus PR forms a visible image on a sheet-like recording medium on the basis of image data being input or image data of an image being read. The image forming apparatus corresponds to a copying machine, a printer, a facsimile machine, or a digital multifunction peripheral including at least two of the functions of these machines, for example. The image forming apparatus PR may employ any known image forming method such as an electrophotographic system or a liquid droplet ejection system.

The saddle stitch book binding device **2** illustrated in FIG. **1** includes an inlet conveyance path **241**, a sheet-through conveyance path **242**, and a center folding conveyance path **243**. Provided at an uppermost stream part of the inlet conveyance path **241** in a sheet conveyance direction is an inlet roller **201** through which the aligned sheet bundle is conveyed into the apparatus from the sheet bundle discharge roller **10** of the first sheet processing apparatus **1**. Note that in the description below, an upstream side of the sheet conveyance direction and a downstream side of the sheet conveyance direction are simply referred to as an upstream side and a downstream side, respectively.

A bifurcating claw **202** is provided on the downstream side of the inlet roller **201** of the inlet conveyance path **241**.

The bifurcating claw **202** installed in a horizontal direction in FIG. **1** bifurcates the conveyance direction of the sheet bundle into the sheet-through conveyance path **242** or the center folding conveyance path **243**.

The sheet-through conveyance path **242** extending horizontally from the inlet conveyance path **241** is a conveyance path that guides the sheet bundle to a processing apparatus (not illustrated) in the following stage or to a paper discharge tray, and the sheet bundle is discharged to the following stage by an upper paper discharge roller **203**.

The center folding conveyance path **243** extending perpendicularly below the bifurcating claw **202** is a conveyance path that performs a saddle stitching/center folding process on the sheet bundle.

The center folding conveyance path **243** includes an upper bundle conveyance guide board **207** which guides the sheet bundle in a part above a folding plate **215** performing center-

folding and a lower bundle conveyance guide board **208** which guides the sheet bundle within a part below the folding plate **215**.

The upper bundle conveyance guide board **207** is provided with, from the upper part, an upper bundle conveyance roller **205**, a rear end hitting claw **221**, and a lower bundle conveyance roller **206**. The rear end hitting claw **221** is erected against a rear end hitting claw drive belt **222** which is driven by a drive motor not illustrated. The rear end hitting claw **221** hits (presses) a rear end of the sheet bundle to the side of a movable fence, to be described, by the reciprocating rotational motion of the rear end hitting claw drive belt **222** and thus performs an alignment operation of the sheet bundle. Moreover, the rear end hitting claw retreats from the center folding conveyance path **243** of the upper bundle conveyance guide board **207** (to a position indicated by a dotted line in FIG. **1**) when the sheet bundle is brought in or raised for center folding.

A reference numeral **294** is a rear end hitting claw HP sensor which detects a home position of the rear end hitting claw **221**, and detects the position indicated by the dotted line in FIG. **1** (a position indicated by a solid line in FIG. **2**) as the home position of the rear end hitting claw retreated from the center folding conveyance path **243**. The rear end hitting claw **221** is controlled on the basis of this home position.

The lower bundle conveyance guide board **208** is provided with, from the upper part, a saddle stitching stapler S**1**, a saddle stitching jogger fence **225**, and a movable fence **210**. The lower bundle conveyance guide board **208** is a guide board that receives the sheet bundle conveyed through the upper bundle conveyance guide board **207**, and is provided with a pair of the saddle stitching jogger fences **225** installed in a width direction. Provided below the saddle stitching jogger fence **225** is the movable fence **210** that can move up and down while abutting on (supporting) an edge of the sheet bundle.

The saddle stitching stapler S**1** stitches a center part of the sheet bundle. The movable fence **210** can move in a vertical direction while supporting the edge of the sheet bundle. Accordingly, a stapling process, namely the saddle stitching, is performed at a central position of the sheet bundle when the central position is moved to a position facing the saddle stitching stapler S**1**.

The movable fence **210** is supported by a movable fence drive mechanism **210***a* and can move from the position of a movable fence HP sensor **292** illustrated in the upper part down to the lowermost position. The movable range of the movable fence **210** abutting on the edge of the sheet bundle ensures a stroke covering the maximum size to the minimum size the saddle stitch book binding device **2** can process. Note that a rack and pinion mechanism is employed as the movable fence drive mechanism **210***a*, for example.

Provided between the upper and lower bundle conveyance guide boards **207** and **208**, namely, at a roughly center part of the center folding conveyance path **243**, are the folding plate **215**, a folding roller pair **230**, an additional folding roller unit **260**, and a lower paper discharge roller **231**.

The additional folding roller unit **260** is used to reinforce the folding line portion by pressurizing the folding line portion of the sheet bundle again, where an additional folding roller is disposed above and below a paper discharge conveyance path that is provided between the folding roller pair **230** and the lower paper discharge roller **231**.

The folding plate **215** can move back and forth in the horizontal direction in the figure, and a nip of the folding roller pair **230** is located in a direction into which the folding operation is performed. A paper discharge conveyance path **244** is installed at a position along the extension of the nip. The lower paper discharge roller **231** is provided at the lowermost stream of the paper discharge conveyance path **244** and discharges the folded sheet bundle to the following stage.

A sheet bundle detection sensor **291** is provided at the lower end side of the upper bundle conveyance guide board **207** to detect the edge of the sheet bundle that is brought into the center folding conveyance path **243** and passes through the center fold position. Moreover, the paper discharge conveyance path **244** is provided with a fold passing sensor **293** which detects the edge of the center-folded sheet bundle and recognizes the sheet bundle passing through.

Generally, the saddle stitch book binding device **2** configured as illustrated in FIG. **1** performs the saddle stitching/center folding operation as illustrated in each of FIGS. **2** to **6** illustrating the operation. That is, when the saddle stitching/center folding operation is selected by an operation panel (not illustrated) of the image forming apparatus PR, the sheet bundle selected to undergo the saddle stitching/center folding operation is guided to the side of the center folding conveyance path **243** by a displacement motion of the bifurcating claw **202** in a counterclockwise direction. Note that the bifurcating claw **202** is driven by a solenoid but may also be driven by a motor instead.

A sheet bundle SB brought into the center folding conveyance path **243** is conveyed downward through the center folding conveyance path **243** by the inlet roller **201** and the upper bundle conveyance roller **205**, while the sheet bundle detection sensor **291** detects a passing state of the sheet bundle.

Once the passing of the sheet bundle SB is confirmed, the sheet bundle is conveyed by the lower bundle conveyance roller **206** to the position at which the edge of the sheet bundle SB abuts on the movable fence **210**, as illustrated in FIG. **2**. At this time, the movable fence **210** stands by at a different stop position according to sheet size information from the image forming apparatus PR or, in this case, size information of each sheet bundle SB in the conveyance direction. FIG. **2** illustrates a state where the sheet bundle SB is nipped by the nip of the lower bundle conveyance roller **206** while the rear end hitting claw **221** stands by at the home position.

The nip pressure by the lower bundle conveyance roller **206** is released (in a direction indicated by an arrowed line "a") in this state as illustrated in FIG. **3**. Following this operation, the edge of the sheet bundle abuts on the movable fence **210** so that the sheet bundle is stacked with a free rear end, at which time the rear end hitting claw **221** is driven and performs the final alignment in the conveyance direction (in a direction indicated by an arrow "c") by hitting the rear end of the sheet bundle SB.

Subsequently, an alignment operation in the width direction (a direction orthogonal to the sheet conveyance direction) is completed by the saddle stitching jogger fence **225**. Each of the movable fence **210** and the rear end hitting claw **221** performs an alignment operation in the conveyance direction, whereby the alignment operation of the sheet bundle SB in both the width direction and the conveyance direction is completed.

Here, the alignment is performed while changing the amount to be pushed in by the rear end hitting claw **221** and the saddle stitching jogger fence **225** to an optimal value according to the sheet size information, number of sheets information of the sheet bundle, and sheet bundle thickness information.

It is often the case that the sheet bundle cannot be aligned completely in one alignment operation when the sheet bundle is thick because a space in the conveyance path is decreased.

The number of alignments is increased in such case, thereby realizing a better alignment state. Moreover, it takes more time to stack the sheet successively on the upstream side as the number of sheets increases, whereby more time is required before a next sheet bundle SB can be accepted. As a result, the satisfactory alignment state can be realized efficiently because there is no time loss as a system when the number of alignments is increased. It is therefore possible to control the number of alignments in accordance with the processing time required on the upstream side.

Note that the stand-by position of the movable fence **210** is normally set at a position where the saddle stitch position of the sheet bundle SB faces the stitch position of the saddle stitching stapler S1. This allows the sheet bundle to undergo the stitching process where it is stacked without moving the movable fence **210** to the saddle stitch position of the sheet bundle SB. Now, at the stand-by position, a stitcher of the saddle stitching stapler S1 is driven in a direction indicated by an arrowed line "b" to the center part of the sheet bundle SB and performs the stitching process with a clincher, thereby saddle stitching the sheet bundle SB.

The positioning of the movable fence **210** is performed by pulse control from the movable fence HP sensor **292**, while the positioning of the rear end hitting claw **221** is performed by pulse control from the rear end hitting claw HP sensor **294**. The positioning control for the movable fence **210** and the rear end hitting claw **221** is executed by a CPU of a control circuit (not illustrated) of the saddle stitch book binding device **2**.

The sheet bundle SB that is saddle stitched as illustrated in FIG. **3** is now transported to a position at which the saddle stitch position (the center position of the sheet bundle SB in the conveyance direction) faces the folding plate **215** along the upward movement of the movable fence **210** while the pressurization by the lower bundle conveyance roller **206** is released, as illustrated in FIG. **4**. This position as well is controlled on the basis of a position detected by the movable fence HP sensor **292**. The folding plate **215** is a member that exerts a function to be described as a folding unit that folds in the sheet bundle.

Once the sheet bundle SB reaches the position illustrated in FIG. **4**, the folding plate **215** is moved toward the nip of the folding roller pair **230**, abuts on the sheet bundle SB, from a direction roughly perpendicular to the sheet bundle, in the vicinity of a needle portion at which the sheet bundle SB is stitched, and then pushes out the sheet bundle to the side of the nip. Pushed by the folding plate **215**, the sheet bundle SB is guided to the nip of the folding roller pair **230** and pushed into the nip of the folding roller pair **230** that has been rotating. The folding roller pair **230** pressurizes and conveys the sheet bundle SB being pushed into the nip. The sheet bundle SB is folded at the center by this pressurization/conveyance operation, whereby a simply bound sheet bundle SB is formed. FIG. **5** illustrates a state where the edge of a folding line portion SB**1** of the sheet bundle SB is nipped and pressurized by the nip of the folding roller pair **230**.

The sheet bundle SB folded in half at the center as illustrated in FIG. **5** is conveyed, as the sheet bundle SB, by the folding roller pair **230** and discharged to the following stage while nipped by the lower paper discharge roller **231**, as illustrated in FIG. **6**. When the rear end of the sheet bundle SB is detected by the fold passing sensor **293**, the folding plate **215** and the movable fence **210** return to the home position and the lower bundle conveyance roller **206** to the pressurizing state, and prepare for the next sheet bundle SB to be brought in. The movable fence **210** may be moved to the position illustrated in FIG. **2** again and stand by when a next job has the same size and number of sheets. Note that these controls are also executed by the CPU of the control circuit.

FIG. **7** is a set of front views illustrating a principal part of the additional folding roller unit **260** and the folding roller pair **230**, and FIG. **8** is a side view illustrating a principal part of FIG. **7** seen from a left side.

As illustrated in FIG. **6**, the additional folding roller unit **260** is installed at the paper discharge conveyance path **244** positioned between the folding roller pair **230** and the lower paper discharge roller **231**. The additional folding roller unit **260** includes a unit moving mechanism **263**, a guiding member **264**, and a pressing mechanism **265**. The unit moving mechanism **263** moves the additional folding unit **260** back and forth along the guiding member **264** in a depth direction in the figure (a direction orthogonal to the sheet conveyance direction). The unit moving mechanism **263** includes a driving source and a drive mechanism that are not illustrated but provided to move the additional folding roller unit **206**. The pressing mechanism **265** presses the sheet bundle SB by applying pressure thereto in the vertical direction and includes, in order to perform this action, an additional folding roller/upper unit **261** and an additional folding roller/lower unit **262**.

The additional folding roller/upper unit **261** is supported by a support member **265***b* to be able to move in the vertical direction with respect to the unit moving mechanism **263**. That is, the additional folding roller/lower unit **262** is immovably attached to the lower end of the support member **265***b* of the pressing mechanism **265**. An upper additional folding roller **261***a* of the additional folding roller/upper unit **261** can be pressed against a lower additional folding roller **262***a*. As a result, the sheet bundle SB can be pressurized when nipped between the nips of the both rollers. The pressurizing force used to pressurize the sheet bundle SB is given by a pressurizing spring **265***c*, the elastic force of which applies pressure to the additional folding roller/upper unit **261**. While in the pressurizing state, the additional folding roller moves in a width direction (a direction indicated by an arrowed line D1 in FIG. **8**) of the sheet bundle SB and performs additional folding of the fold portion SB**1** as will be described later.

FIG. **9** is a diagram illustrating the guiding member **264** in detail. The guiding member **264** includes a guide path **270** which guides the additional folding roller unit **260** in the width direction of the sheet bundle SB, where six paths are set in the guide path **270** including:

1) a first guide path **271** which guides the pressing mechanism **265** in a non-pressed state at the time of forward movement;

2) a second guide path **272** which guides the pressing mechanism **265** in a pressed state at the time of forward movement;

3) a third guide path **273** which switches a pressing mechanism **265** from the non-pressed state to the pressed state at the time of forward movement;

4) a fourth guide path **274** which guides the pressing mechanism **265** in the non-pressed state at the time of backward movement;

5) a fifth guide path **275** which guides the pressing mechanism **265** in the pressed state at the time of backward movement; and

6) a sixth guide path **276** which switches the pressing mechanism **265** from the non-pressed state to the pressed state at the time of backward movement.

FIGS. **10** and **11** are enlarged views illustrating the principal part of FIG. **9**. As illustrated in FIGS. **10** and **11**, a first path switching claw **277** and a second path switching claw **278** are installed at an intersection between the third guide path **273**

and the second guide path **272** and at an intersection between the sixth guide path **276** and the fifth guide path **275**, respectively. As illustrated in FIG. **11**, the first path switching claw **277** can switch a path from the third guide path **273** to the second guide path **272**, while the second path switching claw **278** can switch a path from the sixth guide path **276** to the fifth guide path **275**. The former however cannot switch a path from the second guide path **272** to the third guide path **273**, and the latter cannot switch a path from the fifth guide path **275** to the sixth guide path **276**. In other words, the path switching claws are configured to not be able to switch a path in a reverse direction. Note that an arrowed line illustrated in FIG. **11** indicates a locus of movement of a guide pin **265***a* included in the pressing mechanism **265** (see FIGS. **7**, **23**(B) and **24**).

The pressing mechanism **265** can move along the guide path **270** because the guide pin **265***a* of the pressing mechanism **265** is movably engaged within the guide path **270** in loose engagement. That is, the guide path **270** functions as a cam groove, and the guide pin **265***a* functions as a cam follower that shifts while moving along the cam groove.

FIGS. **12** to **22** are diagrams illustrating the additional folding operation performed by the additional folding roller unit of the present embodiment.

FIG. **12** illustrates a state where the sheet bundle SB folded by the folding roller pair **230** is conveyed and stopped at a preset additional folding position while the additional folding roller unit **260** is at a standby position. This is the initial position of the additional folding operation.

The additional folding roller unit **260** starts the forward movement from the initial position (FIG. **12**) into a right direction as illustrated in the figure (a direction indicated by an arrowed line D**2**) (FIG. **13**). Here, the pressing mechanism **265** in the additional folding roller unit **260** moves along the guide path **270** of the guiding member **264** by the action of the guide pin **265***a*. The additional folding roller unit moves along the first guide path **271** right after the operation is started. The pair of additional folding rollers **261***a* and **262***a* is in the non-pressed state at this time. Here, the non-pressed state represents a state where the additional folding rollers **261***a* and **262***a* are in contact with the sheet bundle SB but hardly applying pressure thereto, or a state where the additional folding rollers **261***a* and **262***a* are separated from the sheet bundle SB.

Having come to the third guide path **273** near the center of the sheet bundle SB (FIG. **14**), the pressing mechanism **265** starts descending along the third guide path **273** and enters the second guide path **272** by pushing aside the first path switching claw **277** (FIG. **15**). The pressing mechanism **265** here presses the additional folding roller/upper unit **261** so that the additional folding roller/upper unit **261** abuts on the sheet bundle SB and is in the pressed state therewith.

The additional folding roller unit **260** further moves in the direction indicated by the arrowed line D**2** while keeping the pressed state (FIG. **16**). At this time, the additional roller unit moves along the second guide path **272** without being guided by the sixth guide path **276** because the second path switching claw **278** cannot move in the reverse direction, passes through the sheet bundle SB, and is positioned at the final position of the forward movement (FIG. **17**). Having moved to this point, the guide pin **265***a* of the pressing mechanism **265** now shifts from the second guide path **272** to the fourth guide path **274** thereabove. As a result, the position of the guide pin **265***a* is not controlled by the upper surface of the second guide path **272** anymore, whereby the upper additional folding roller **261***a* is separated from the lower additional folding roller **262***a* to be in the non-pressed state.

Next, the additional folding roller unit **260** starts the backward movement by the unit moving mechanism **263** (FIG. **18**). In the backward movement, the pressing mechanism **265** moves to the left as illustrated in the figure (a direction indicated by an arrowed line D**3**) along the fourth guide path **274**. When the pressing mechanism **265** moves and comes to the sixth guide path **276** (FIG. **19**), the guide pin **265***a* is pushed downward along the shape of the sixth guide path **276** so that the pressing mechanism **265** shifts from the non-pressed state to the pressed state (FIG. **20**).

The pressing mechanism is in the completely pressed state once entering the fifth guide path **275**, moves through the fifth guide path **275** in the direction indicated by the arrowed line D**3** (FIG. **21**), and then passes through the sheet bundle SB (FIG. **22**).

The additional folding is applied to the sheet bundle SB by moving the additional folding roller unit **260** back and forth, as described above. At this time, the additional folding roller unit starts the additional folding of the sheet bundle SB from the center part thereof toward one side, and passes through one edge SB**2-1** of the sheet bundle SB (FIG. **17**). Subsequently, the additional folding roller unit starts the additional folding of the sheet bundle from the center part thereof toward another side by passing above the additionally-folded sheet bundle SB, and passes through another edge SB**2-2** (FIG. **22**).

Operated in the aforementioned manner, the pair of additional folding rollers **261***a* and **262***a* do not contact or pressurize the edge SB**2-1** of the sheet bundle SB from outside thereof when starting the additional folding or returning to the other edge SB**2-2** of the sheet bundle SB after passing through the one edge SB**2-1**. In other words, there is no damage to the edge SB**2-1** of the sheet bundle SB when the additional folding roller unit passes through the edge SB**2-1** of the sheet bundle SB from outside thereof because the additional folding roller unit **260** is in the non-pressed state. It is also less likely that a kink causing a crease or the like builds up because the additional folding is performed from near the center part of the sheet bundle SB toward the edge SB**2-1** and the edge SB**2-2** respectively, allowing the distance traveled by the additional folding roller unit in contact with the sheet bundle SB to be decreased at the time of the additional folding. As a result, there is no damage done to the edges SB**2-1** and **2-2** of the sheet bundle SB in performing the additional folding at the folding line portion (back) SB**1** of the sheet bundle SB, thereby also suppressing a turn-up or a crease at the folding line portion SB**1** or in the vicinity thereof caused by the kink buildup.

The following condition is used in order for the pair of additional folding rollers **261***a* and **262***a* to not run onto the edge SB**2-1** of the sheet bundle SB from outside the edge SB**2-1**. Letting "La" be a distance for which the additional folding roller unit **260** moves on the sheet bundle in the non-pressed state at the time of the forward movement, and "Lb" be a distance for which the additional folding roller unit moves on the sheet bundle in the non-pressed state at the time of the backward movement, as illustrated in the operation in FIGS. **12** to **22**, it is required that the relationship between a length L of the sheet bundle in the width direction thereof and the distances La and Lb satisfy the following (FIGS. **12** to **14** and FIGS. **17** to **19**).

$$L>La+Lb$$

Moreover, it is desired that the pressing be started near the center part of the sheet bundle SB in the width direction thereof by setting the distances La and Lb roughly the same (FIGS. **16** and **20**).

Note that while the additional folding roller unit **260** of the present embodiment performs the additional folding by the pair of additional folding rollers **261***a* and **262***a* with the provision of the additional folding roller/lower unit **262**, another method may be employed. For example, the additional folding roller/lower unit **262** may be eliminated while providing the additional folding roller/upper unit **261** and a receiving member (not illustrated) having an abutment surface facing the additional folding roller/upper unit so that the sheet bundle is pressed between the two.

Furthermore, the additional folding roller unit **260** of the present embodiment includes the additional folding roller/upper unit **261** that is configured to be able to move vertically and the additional folding roller/lower unit **262** that is configured not to move vertically. This configuration can however be replaced by the following.

That is, the additional folding roller/lower unit **262** can be configured to be able to move vertically as well. Such configuration allows the additional folding position to be fixed regardless of the thickness of the sheet bundle SB and further allows damage such as a flaw to be suppressed because the upper and lower additional folding rollers **261***a* and **262***a* move toward and away from each other in a symmetrical manner with respect to the additional folding position.

A characteristic of the sheet processing apparatus including the aforementioned configuration will be described. Note that in FIG. **23**, a member identical to that in FIG. **7** will be indicated with a reference numeral identical to that assigned to the identical member in FIG. **7**.

The characteristic of the sheet processing apparatus according to the present embodiment is that the shaft line direction of the additional folding roller included in the additional folding roller unit **260** can be tilted at the time of pressurization, the additional folding roller unit being a pressing member as a pressing unit used in the additional folding process.

This means that, when in contact with the back of the sheet bundle SB at the time of pressurizing, the additional folding roller can exert pressure while positioning the additional folding roller corresponding to the downstream side of the back of the sheet bundle in the conveyance direction to the lower side in the shaft direction corresponding to the longitudinal direction of the additional folding roller.

FIGS. **23**(A) to **23**(D) are diagrams illustrating a configuration and working of the aforementioned characteristic.

The additional folding roller/upper unit **261** used in the additional folding roller unit **260** rotatably supports the additional folding roller **261***a*, the shaft direction of which corresponds to the longitudinal direction indicated by a reference numeral L and is parallel to the conveyance direction of the sheet bundle SB (a direction indicated by an arrowed line F in FIG. **23**(A)).

The additional folding roller **261***a* is configured to pressurize the sheet bundle SB by a load applied to the roller from a pressurizing spring **265***c* included in the additional folding roller/upper unit **261**.

A plurality of pressurizing springs **265***c* (indicated by reference numerals **265***c***1**, **265***c***2**, and **265***c***3**) is provided in the present embodiment.

An edge of each pressurizing spring, from which the load, is provided at a position to exert the pressurizing force on the downstream side of the back (a position indicated by a reference numeral BF in FIG. **23**(C)) of the sheet bundle SB in the conveyance direction, in the shaft direction of the additional folding roller **261***a*.

Accordingly, as illustrated in FIG. **23**(D), the additional folding roller **261***a* at the time of pressurizing the sheet bundle SB can be tilted to a position where a region of the roller on the downstream side of the nip in the conveyance direction comes below the nip at the time of pressurization, the nip pressurizing the sheet bundle SB in the shaft direction. An arrowed line R illustrated in FIG. **23**(*d*) indicates a direction into which the downstream side of the additional folding roller **261***a* in the conveyance direction is tilted with respect to the shaft direction of the roller.

While the configuration of the present embodiment has been described above, the working of the present embodiment will be described as follows with reference to FIGS. **23**(A) to **23**(D).

FIG. **23**(A) illustrates a state where the sheet bundle SB is conveyed from a folding roller not illustrated to the additional folding position along a conveyance direction F.

The back (BF) of the sheet bundle SB in this state is positioned and nipped on the upstream side of a range in the conveyance direction, the range being occupied by the pressurizing spring **265***c* in the shaft direction of the additional folding roller **261***a*.

FIG. **23**(B) illustrates a state where the sheet bundle SB is pressurized by the pressing mechanism **265** between the additional folding roller/upper unit **261** and the additional folding roller **262***a* on the side of the additional folding roller/lower unit **262** facing the additional folding roller **261***a* of the additional folding roller/upper unit **261**.

The additional folding roller/upper unit **261** in this state is pressed by the pressing mechanism and descends toward the sheet bundle SB. As the additional folding roller/upper unit **261** keeps descending, the additional folding roller **261***a* is brought into contact with the sheet bundle SB and starts the additional folding while applying pressure.

At the start of the additional folding, as illustrated in FIG. **23**C, the load applied by the plurality of pressurizing springs **265***c***1** to **265***c***3** to the additional folding roller/upper unit **261** reaches the downstream side of the conveyance direction beyond the position of the back BF, in the conveyance direction of the sheet bundle SB. Therefore, the additional folding roller **261***a* corresponding to the downstream side of the conveyance direction can be tilted downward while having the nip that is in contact with the sheet bundle SB in the shaft direction as a fulcrum.

The arrowed line R illustrated in FIG. **23**(D) indicates the direction into which the additional folding roller/upper unit **261** supporting the additional folding roller **261***a* is tilted from the state before coming into contact with the sheet bundle, and also indicates that the state of the additional folding roller **261***a* is changed from a state before the roller is in contact with the sheet bundle SB.

Accordingly, the edge of the additional folding roller **261***a* in the shaft direction is lifted from the nip portion positioned on the upstream side of the conveyance direction of the sheet bundle SB, whereby the edge of the roller does not pressurize the nip portion. As a result, there can be prevented the pressurized mark caused when the edge of the roller pressurizes the nip portion unintentionally and carelessly due to the dimensional variation or rigidity of a component of the additional folding mechanism.

A variation of the principal part illustrated in FIG. **23** will now be described.

FIG. **24** illustrates a configuration, as the variation, where the shaft direction of the additional folding roller **261***a* is tilted beforehand such that the downstream side of the roller in the conveyance direction of the sheet bundle SB is positioned on the lower side.

Letting "d1" be a gap between the nips at the position of the back BF corresponding to the fold position of the sheet bundle

SB and "d2" be a gap between the nips on the downstream side of the conveyance direction, a relationship d1>d2 is determined in this case.

As a result, the downstream side of the additional folding roller **261***a* in the conveyance direction is tilted downward.

In the configuration illustrated in FIGS. **23** and **24** as described above, the load applied to the sheet bundle SB is distributed as follows by the positioning of the pressurizing spring **265**.

That is, the load distribution is more intense on the downstream side of the conveyance direction than at the nip portion on the upstream side of the conveyance direction when the position of the back BF of the sheet bundle SB corresponding to the fold position is provided as a reference.

This can almost surely avoid the case where the upstream side of the additional folding roller **261***a* in the conveyance direction comes into contact with the nip portion of the sheet bundle SB, thereby eliminating the chance of leaving the pressurized mark generated when the sheet bundle SB is pressurized by the edge of the roller on the upstream side of the conveyance direction.

According to the present invention, the impact of pressurization by a pressing member is reduced on an upstream side of a conveyance direction due to the configuration where the pressing member pressurizes while a downstream side of the conveyance direction is positioned on the lower side relative to the fold position in the conveyance direction of the sheet bundle. As a result, there can be prevented a case where the pressurized mark is unintentionally and carelessly left in the sheet bundle on the upstream side of the conveyance direction when the pressurized state of the pressing member with respect to the fold position is changed by a mechanical error of a member used in the additional folding mechanism.

Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

What is claimed is:

1. A sheet processing apparatus, comprising:

a pressing roller configured to press a folding line portion of a folded sheet bundle in a direction of a thickness of the folded sheet bundle;

an elastic member positioned downstream in relation to the pressing roller so as to press a part of the pressing roller corresponding to a downstream side of a conveyance direction of the sheet bundle; and

a moving unit configured to move the pressing member to a folding line direction of the sheet bundle.

2. The sheet processing apparatus according to claim **1**, wherein

the part of the sheet bundle corresponding to the downstream side of the conveyance direction corresponds to a part of the sheet bundle positioned at a downstream side of the conveyance direction beyond a position of a back of the sheet bundle folded back along a position of the folding line portion.

3. The sheet processing apparatus according to claim **1**, wherein

the pressing roller applies a load at the position of the folding line portion of the sheet bundle.

4. The sheet processing apparatus according to claim **1**, wherein

a distribution of the load applied by the pressing roller is determined to be more intense in the part corresponding to the downstream side of the conveyance direction beyond the position of the folding line portion than in a nipped part not beyond the position of the folding line portion.

5. The sheet processing apparatus according to claim **1**, wherein

the pressing roller includes a roller having a shaft line being located in the conveyance direction of the sheet bundle, and the roller is configured to be able to change, when the roller comes into contact with the sheet bundle to pressurize the sheet bundle, tilt of the shaft line of the roller so that a portion of the roller corresponding to the downstream side of the conveyance direction is shifted to contact with a portion of the sheet bundle corresponding to the downstream side of the conveyance direction.

6. The sheet processing apparatus according to claim **5** wherein,

where d1 represents a gap of a nip of the roller at the position of the folding line portion and d2 represents a gap of the nip on the downstream side of the conveyance direction, the roller has a tilt with which the nip at the position of the folding line portion of the sheet bundle acquires a relationship d1>d2.

7. An image processing system comprising an image forming apparatus and a sheet processing apparatus that saddle-stitches a sheet bundle and center-folds the sheet bundle, wherein

the image forming apparatus is used as a preceding apparatus and the sheet processing apparatus is used as a following apparatus, and the image forming apparatus is connected to the sheet processing apparatus at a boundary corresponding to a position at which the sheet bundle is subjected to saddle stitching and center folding; and

the sheet processing apparatus includes:

a pressing roller configured to press a folding line portion of a folded sheet bundle in a direction of a thickness of the folded sheet bundle;

an elastic member positioned downstream in relation to the pressing roller so as to press a part of the pressing roller corresponding to a downstream side of a conveyance direction of the sheet bundle; and

a moving unit configured to move the pressing member to a folding line direction of the sheet bundle.

8. The sheet processing apparatus according to claim **1**, wherein the moving unit moves the pressing roller back and forth along a guiding member, and the pressure is controlled via the movement of the pressure roller on the guiding member.

9. The sheet processing apparatus according to claim **1**, wherein the guiding member includes a guide path which guides the moving unit in a width direction of the sheet bundle.

10. The sheet processing apparatus according to claim **9**, further comprising a plurality of pressing members,

wherein the guide path includes:

a first guide path which guides the pressing members in a non-pressed state at the time of forward movement;

a second guide path which guides the pressing members in a pressed state at the time of forward movement;

a third guide path which switches the pressing members from the non-pressed state to the pressed state at the time of forward movement;

a fourth guide path which guides the pressing members in the non-pressed state at the time of backward movement;

a fifth guide path which guides the pressing members in the pressed state at the time of backward movement; and

a sixth guide path which switches the pressing members from the non-pressed state to the pressed state at the time of backward movement.

11. The sheet processing apparatus according to claim **10**, further comprising a first path switching claw and a second path switching claw.

12. The sheet processing apparatus according to claim **11**, wherein the first path switching claw and the second path switching claw are installed at an intersection between the third guide path and the second guide path and at an intersection between the sixth guide path and the fifth guide path, respectively.

13. The sheet processing apparatus according to claim **11**, wherein the first path switching claw can switch a path from the third guide path to the second guide path, while the second path switching claw can switch a path from the sixth guide path to the fifth guide path.

14. The sheet processing apparatus according to claim **9**, wherein the guiding member slopes at a center thereof in a direction orthogonal to the conveyance direction of the sheet bundle.

15. The sheet processing apparatus according to claim **9**, further comprising a guide pin,

wherein the pressing members move along the guide path of the guiding member by an action of the guide pin.

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